VOLUME 32, NO.4 • THE GEORGE WASHINGTON UNIVERSITY • EDITION 2, FALL 1985

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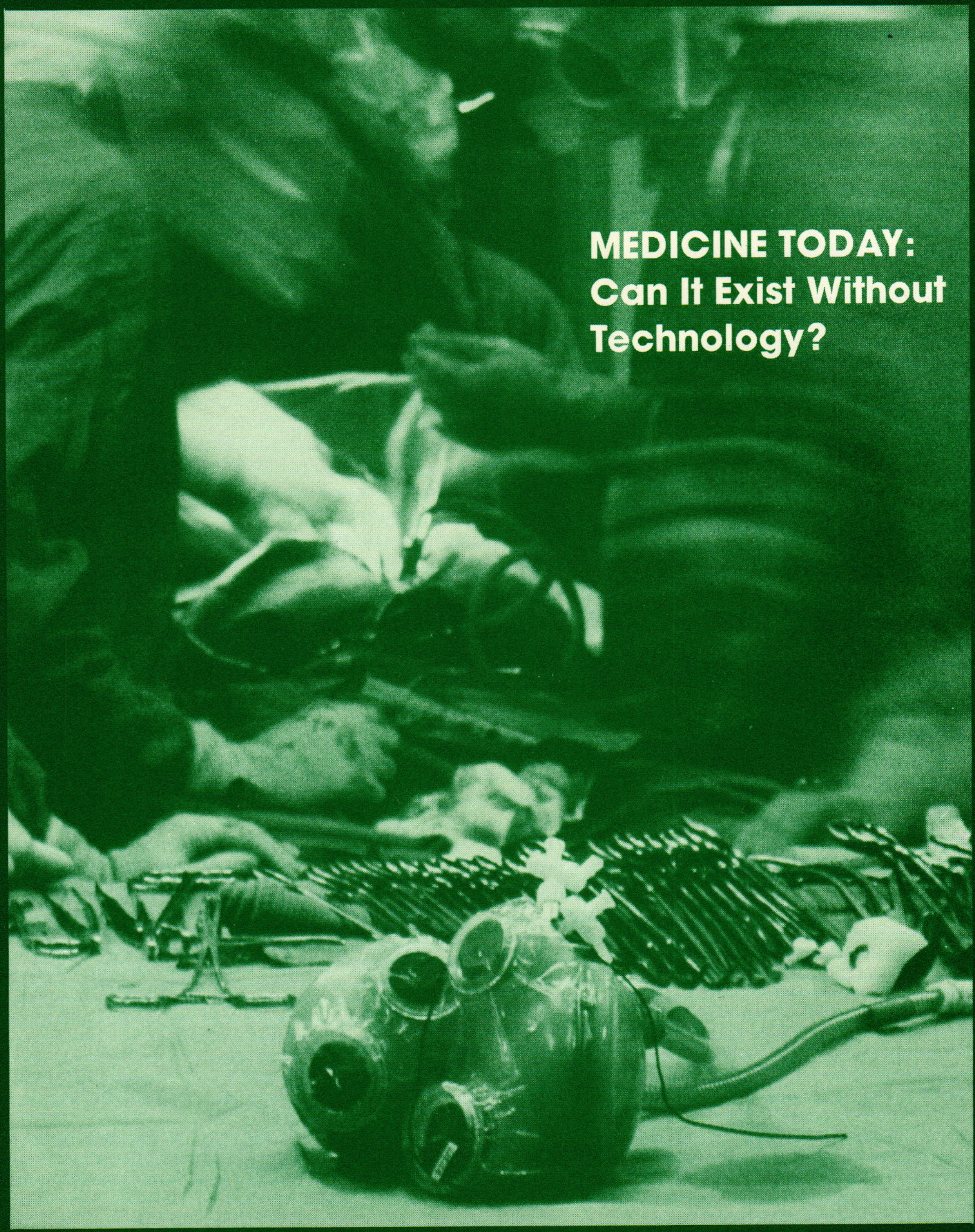

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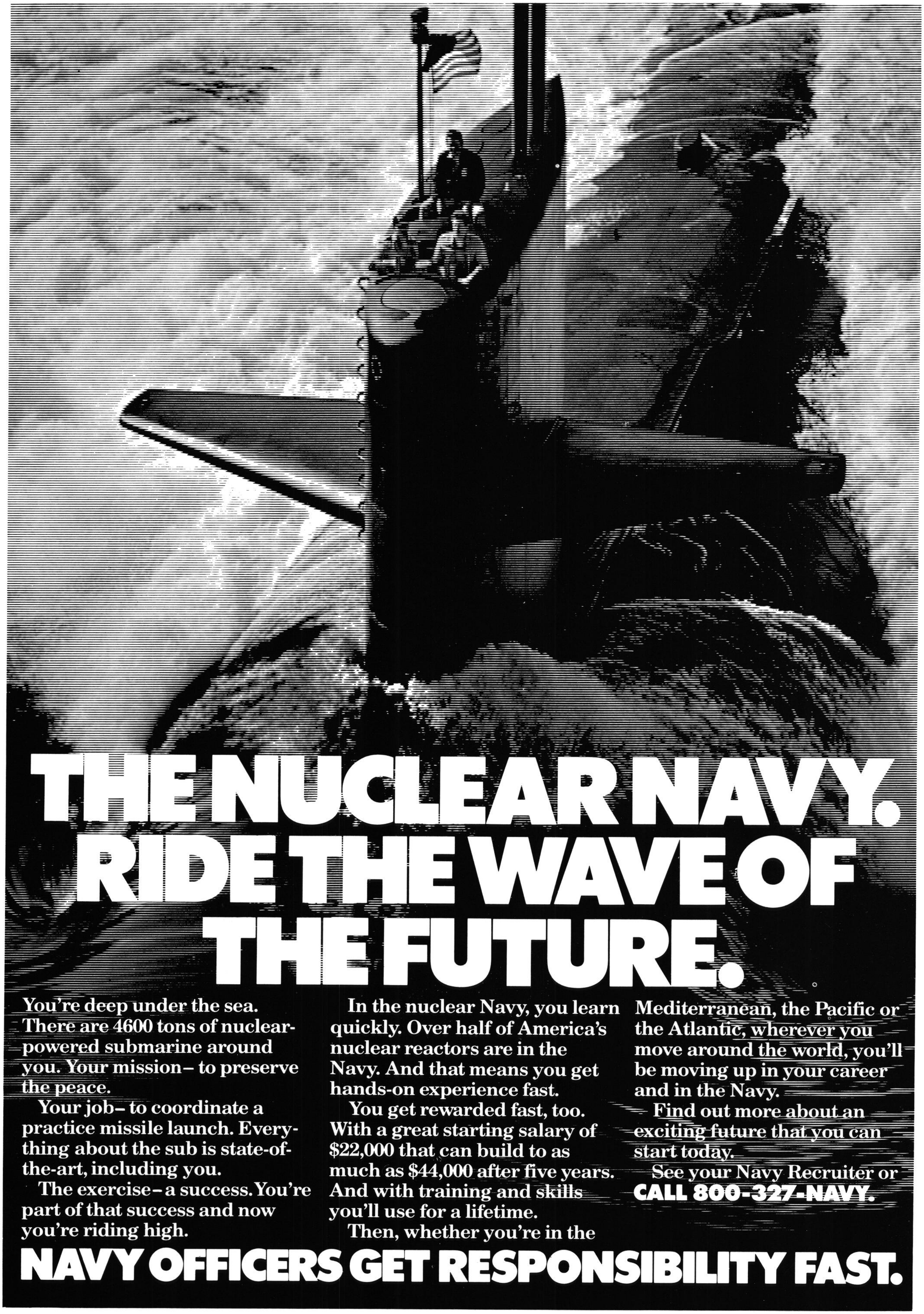
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The Artificial Heart: Will It Conquer Heart Disease?

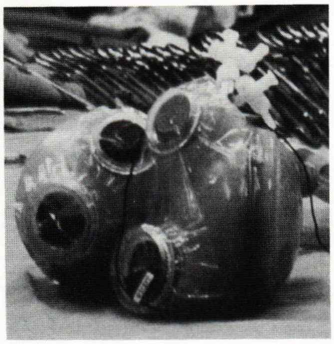
by Stephen A. Osella

Publicity and controversy have surrounded the fledgling implants of the Jarvik-7 heart. Is this device, or the new heart being developed at Penn State, the answer to humanity's battle against degenerative heart disease? **4**

Computer-Made Joints: Marrying Medicine and Mechanics

by April Stokes

The first artificial limbs and joints were crude approximations that often didn't fit a person's natural bone structure. Today, surgeons are using computers to mold precision parts that make the dream of a bionic person just a little closer in our future. **8**



COVER: The Jarvik-7 heart sits on the operating table, waiting to replace William Schroeder's decayed one. Schroeder, the second-ever recipient of the Jarvik-7, is still alive today, nearly a year after the operation. Courtesy of TIME.

Satellite Technology Comes Down to Earth to Treat Heart Patients

by Deirdre Maull

Space technology has influenced our daily lives for more than a decade. Now, pacemakers and other cardiac-assist devices are also benefitting from the knowledge gained from satellite construction. **11**

Living On The Wire: Inside a Modern Shock Trauma Unit

by Lilimar Avelino and Swati Patel

A few seconds are often all that separate life from death for accident victims. Today's modern shock trauma units combine state-of-the-art technology with attentiveness to duty to save lives every day. **13**

Is There Life Beyond Tompkins Hall?: Making the Transition to the "Real World"

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Are you scared or apprehensive about entering the workplace after graduation? Just a few small tips may help you score valuable points with bosses and fellow co-workers and put you on the road to a successful career. **19**

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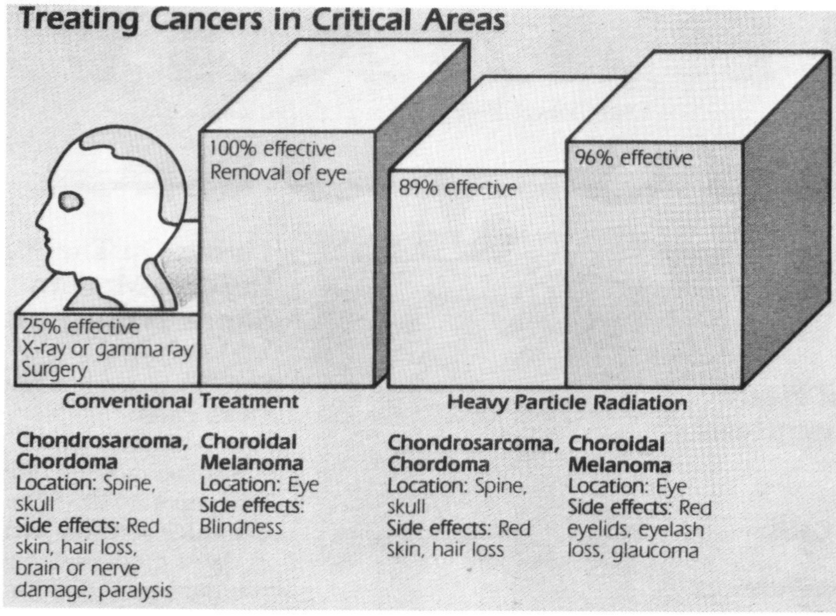


Heavy particle radiation is highly effective and has none of the harmful side effects of earlier treatments. Courtesy of Science Digest.

Heavy Particle Radiation Prevails over Conventional Radiation

"RADIATION THERAPY is a local treatment for cancer which can be administered externally or internally. The path of the radiation depends on the cell type, location, size and age of the cancer, the patient, and the most effective therapy for a specific cancer. It is estimated that over 50 percent of the patients diagnosed as having cancer will be treated with radiation therapy at some point in the course of their illness.

Two types of radiation used in the treatment of cancer are conventional, electromagnetic radiation using gamma rays and X-rays, and heavy particle radiation using protons and helium ions. Two prevalent problems with the more common conventional radiation therapy are that it kills healthy cells in the path towards the tumor, and that side effects (like paralysis and hair loss) occur. In contrast, the relatively new heavy particle radiation therapy centers its radiation at the base of the tumor with only minimal damage to healthy cells. As a specific example, Massachusetts General Hospital showed a 96 percent success when treating a patient with a proton beam. Applying a pencil-thin beam of helium ions to an eye cancer patient was 93 percent successful in shrinking the tumor and arresting its growth.

In studies of 6,000 patients, heavy particle radiation was very effective in treating cancers of the eye, spine, and the base of the skull—all with a high risk of injury to the optic nerve or central nervous system. While conventional radiation produces blindness with eye cancer therapy, heavy particle radiation treats large tumors of the eye, and at the same time, maintains the patient's vision.

Heavy particle radiation reduces the many risks that exist when utilizing any form of radiation. Although this new treatment appears very promising, the effectiveness of heavy particle radiation therapy is still limited to just three cancers.

—*Swati Patel*

Robot Arm Opens Up New Era In Brain Surgery

"BRAIN SURGERY has to be one of the most demanding careers one can pursue. It calls for the dexterity of a jeweler, the stamina of an athlete, and the discipline of a yogi, not to mention a clever mind and years upon years of schooling. But as with so many other professions, technology is reaching out to make the brain surgeon's job faster, easier, and less tedious. Help comes in the form of a robot arm, developed at the Long Beach Memorial Medical Center in California. This two-foot long arm will allow doctors to reach hitherto unreachable areas of the brain, with greater accuracy and safety than ever possible with human hands.

Perhaps the purpose of this robot is best summarized by the words of its inventor, Dr. Yik San Kwoh. According to Dr. Kwoh, "the robot relieves surgeons of routine tasks, enabling the doctor to focus on what he can do best—taking care of the patient." Dr. Kwoh, an electrical engineer by trade, has built an apparatus tailor-made to the needs of a brain surgeon. He combined a common industrial-type robot, an existing stereotactic frame, and appropriate computer hardware and software. Out of this assortment of mechanical, electronic, and computer ingredients has emerged a working, operating room device that can guide instruments into a patient's brain with an accuracy of one two-thousandth of an inch.

The Ultimate PUMA 200 robot used by Dr. Kwoh looks and works remarkably like a human arm. Each of its six joints mimics a particular joint in the human body, for example, the shoulder, elbow, or wrist. The major improvements it offers over a human arm are increased flexibility, i.e. greater

swivel angles than humanly possible, and superhuman precision. The robot is also portable enough to easily maneuver around an operating room, and at the same time, sturdy enough to safely guide a needle-tip probe into the incredibly delicate regions of the brain.

The PUMA 200 is not just a hand groping blindly within the skull, however. Sophisticated electronic technology, in the form of a CAT scanner and several mini and micro computers, provides the "eyes" to help it locate its target. Before the arm is even brought close to a patient's head, many CAT scans or "cutaway views" of the head are taken. From these, using an ordinary computer terminal, the surgeon decides on the precise point of attack for the arm and a trajectory for it to follow through the skull. This technique is far from perfect at this time, because the two-dimensional coordinates taken by the CAT scan must be converted into three-dimensional coordinates within the head.

Throughout the operation, the patient's head is fixed in place by a special ring-shaped headrest and four stainless steel screws. He or she can remain awake for the entire time, with only a local anesthesia. Post-operative recovery time for a simple biopsy extraction has been reduced from one week to overnight. Since the arm is so pinpoint accurate, only a tiny hole need be drilled in the skull, and two stitches are often all that is needed to close it. This is extremely beneficial since the larger the hole is made, the greater is the risk of post-operative swelling of the brain.

For you engineers who may be considering a career in the medical professions, Dr. Kwoh's history is an excellent case in point. He came to the US in 1968 and received his BS in Electrical Engineering from Louisiana Tech and his Ph.D. from USC. He spent years researching the possible applications of computers in medicine and at last has designed something that is helping to cure people. Perhaps nowhere else in engineering are the potential satisfactions as great as seeing your own invention save lives and heal others.

There are, of course, serious ethical questions to be carefully contemplated. Many people may have terrifying science fiction-type

Continued on page **18**

Dr. Yik San Kwoh demonstrates the Unimate PUMA 200 robot arm he adapted for use by brain surgeons. Courtesy of People Weekly.

THE ARTIFICIAL HEART: WILL IT CONQUER HEART DISEASE?

by Stephen A. Osella

"EVERYONE NOWADAYS HAS their own opinion on the artificial heart. Since the operation was performed there has been much controversy about the morals and ethics involved in the artificial heart implants. Making matters worse, nothing has happened in the past three years to relieve most people of their misgivings about the machine. In effect, the only way to end the opposition to the artificial heart is for the technology to reach the point where, in the words of Robert Jarvik, "It [the artificial heart] must be more than functional, reliable and dependable. It must be **forgettable**."

The history of the artificial heart could be traced back to early 19th century experiments with mechanical perfusion. These experiments attempted to sustain the life of muscles and organs by pumping oxygen-enriched blood to isolated body parts. These early studies actually led to the development of the heart-lung machine used in modern open heart surgery. The experience gained from perfusion and heart bypass machine experiments by consequence implied the possibility of replacing the heart altogether.

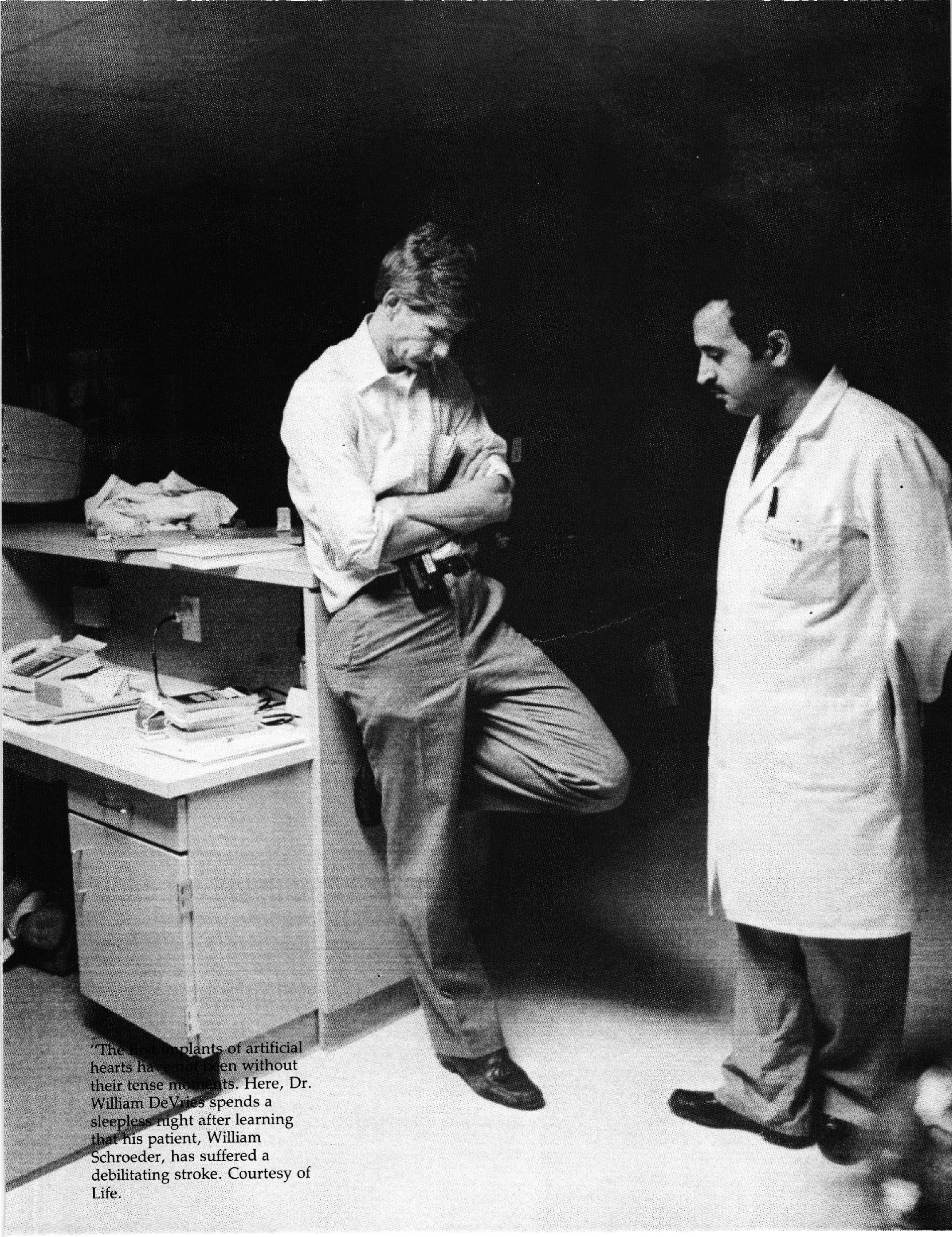
The first experiments with a total artificial heart were done in the 1950's by Willem J. Kolff when he came to the United States to work at Ohio's Cleveland Clinic. Kolff's background in artificial human organs dates back to the Second World War when, in 1941, he built the first successful kidney dialysis machine. In 1967, the University of Utah, where the first artificial heart was implanted, offered him the leadership of its Institute for Biomedical Engineering and Division of Artificial Organs. It was at the University that Robert K. Jarvik, the inventor of the most famous and only permanently implanted artificial heart, became associated with Willem Kolff. Together they began work on the artificial heart and, by 1973, Jarvik began refining the device that evolved into the Jarvik-7. The Jarvik team has since moved away from the University of Utah to the Humana Heart Institute in Louisville, Kentucky, where they have found greater support for their research.

"IN DESIGNING THE FIRST Jarvik artificial heart, certain design criteria had to be considered. Each criterion dealt with one of the following technological problems: developing appropriate biomaterials, a power source and a pump, and a way of simulating the automatic nervous system. The durability of the human heart notwithstanding, the complex regulatory functions and the output requirements of the cardiac system would seemed extremely difficult to duplicate. The mechanical heart would have to be small enough to fit inside the chest cavity vacated by the patient's diseased heart. It would have to provide the necessary blood supply and vary this supply proportionally to the exertion. The mechanism would have to pump the blood at the correct pressure and do so gently enough not to cause hemolysis (destruction of blood cells). Finally, the material used would have to be durable enough to maintain the ceaseless operation, but, at the same time be made of immunologically inert materials.

Due to the little understood interaction between the natural heart and the nervous system, the design specifications for the artificial heart would be mandated by the characteristics of the human heart. The natural heart has four chambers: two atria and two ventricles. It has four valves: two to allow the blood to travel from the atria to the ventricles and the other two to allow the blood to move from the ventricles to the rest of the body via large arteries. The cardiac cycle is divided into the diastole period, when the blood enters the ventricles, and the systole period, when the blood is pumped out of the heart due to contractions of the heart muscle. The atria serve mainly as reservoirs for the blood returning during systole, but also serve as low-stage compressors prepressurizing the blood to make the pumping process more efficient.

About 80 percent of the work produced by the human heart is generated by the left ventricle. The left ventricle pumps blood through arteries to the organs and tissues of the body at pressures greater than 100 millimeters of mercury. The right ventricle does the other 20 percent of the work, but at a much lower pressure, since it only pumps blood to the lungs.

Since the blood pumped from the right ventricle enters the lungs to be fill with oxygen and then returns to the left ventricle, the volume of blood pumped by each side is roughly equal. At rest, the volumetric output of the natural heart is five to six liters per minute and can reach thirty liters with strenuous exercise. The increase is due to more blood being pumped with each heartbeat. The regulatory response to increased exertion is to speed up the heart rate. The higher rate, in turn, increases the volume of the output consequently raising the pressure of the blood returning from circulation. The higher pressure

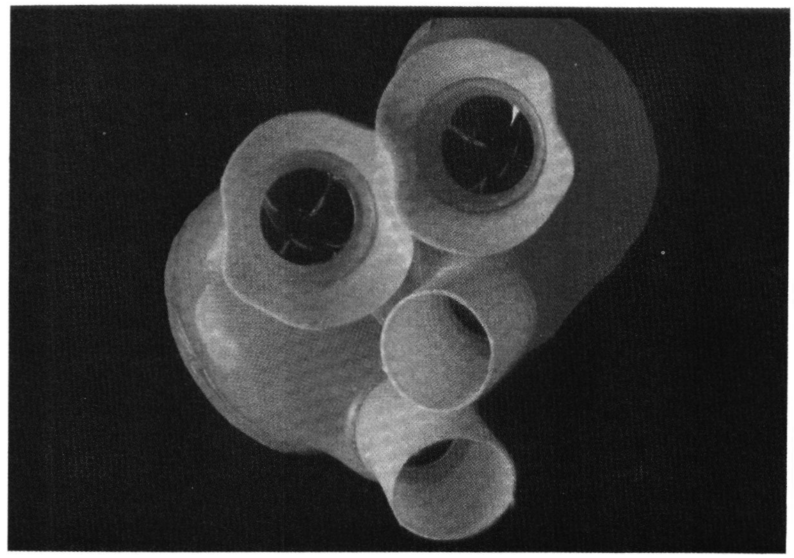


"The first implants of artificial hearts have not been without their tense moments. Here, Dr. William DeVries spends a sleepless night after learning that his patient, William Schroeder, has suffered a debilitating stroke. Courtesy of Life.

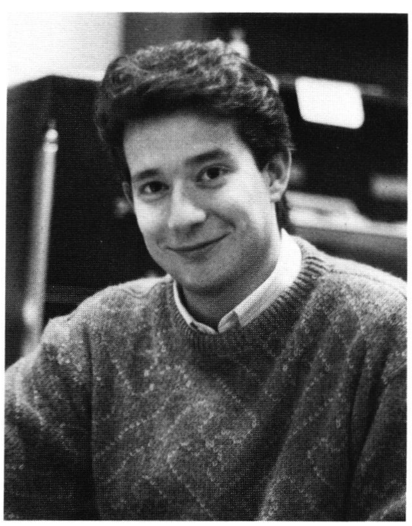
then causes the stroke volume to increase.

Even though there are at least twenty other research groups working on an artificial heart, the Jarvik-7 artificial heart is the only mechanical heart to have been implanted permanently in a human being. For this reason, it has received the most attention and has the best chance of becoming the replacement device, other than a doner's natural heart, for people suffering from advanced cases of cardiomyopathy. This degenerative heart disease causes the wasting away of heart muscles, for which there is no cure other than transplantation.

As with most designs, the Jarvik artificial heart has undergone modifications. Most of the changes dealt with the pumping mechanism, but the materials used were also replaced for immunological reasons. Contrary to popular belief, not all of the natural heart is removed when the artificial one is put in. For this reason, Total Artificial Hearts (TAH) are sometimes mistaken with Ventricle Assist Devices Unlike TAH's, when a Ventricle Assist Device is implanted, the patient's natural heart is not removed.



The Jarvik-7 artificial heart, here seen from above, was the first to be implanted in a human being. Dr. Barnard Clark, the first recipient, lived for 112 days before succumbing to complications and mechanical failure of the heart, itself. Courtesy of the IEEE Spectrum.



KWANG-YONG QUEK

Stephen A. Osella *is a graduate student, in the field of Mechanical Engineering, with an emphasis on Computer-Aided Design. He received his Bachelor's degree from the University of Texas at Austin. Steve is currently very active in organizing MECHELECIV's advertising effort.*

As can be seen in the illustration, the two atria are left intact and the artificial heart is attached to them. The mechanical ventricles are fastened with Velcro fabric fasteners onto two Dacron cuffs, which were stiched to the two atria. The two ventricles of the Jarvik-7 are made of polyurethane and are supported by aluminum bases to prevent air leaks. They are lined with a soft, velvety plastic mesh to minimize hemolysis, the damage to the blood cells. At both entrances to the chambers are rings of polycarbonate which support tilting-disk valves.

The pump diaphragm is connected to the heart wall by the aluminum bottom. This particular diaphragm design characteristic has caused many adverse physiological side effects. Initially, a single 0.030 in. thick layer of silicon rubber was used; however, that proved to be inadequate because it tended to cause areas of low pressure leading to stagnation of the blood flow. In the areas of low fluid velocity, clots would form which would either build up and clog the entrances or would detach from the heart walls. Later versions used a highly flexible three-layer diaphragm made of polyurethane.

Also contributing to the clotting problem is the shape of the ventricle chambers used in the Jarvik-7 design. The configuration used in the heart designed by Dr. Priece and Dr. Rosenberg at Penn State University, which was recently approved for human implant by the Food and Drug Administration (FDA), seems to have decreased the risk of blood clotting by improving the blood flow through the heart.

"A CRITICAL ASPECT OF the artificial heart technology is the power source. Both Jarvik and the engineers at Penn State have experimented on two types of mechanisms: pneumatically powered hearts and those that operate electrically. In the present functioning artificial heart designs, an air compressor "beats" the heart by forcing air through hoses that pass through the skin of the patient and attach to the mechanism. The openings, however, leave the patient vulnerable to fatal infection. Research on this problem is being conducted to seal the tubing with the patient's skin cells. The compressor, which is powered by an electrical power supply, pumps air in, thus inflating the diaphragm and forcing blood out of the heart and throughout the body. The compressor then sucks the air out, creating a vacuum which is then filled by blood entering from the atrium.

The heartbeat rate of the Jarvik-7 is regulated manually; however, engineers at Penn State have improved the regulatory system by automating it. This change in the design should decrease the risk of heart strokes and blood clotting.

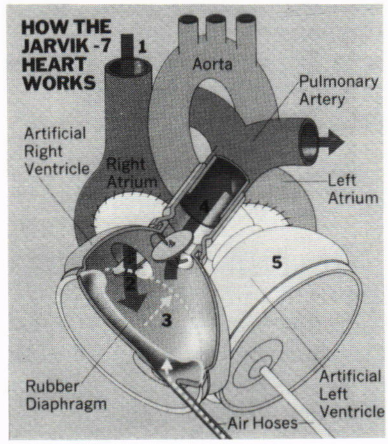
The pneumatically driven artificial heart will eventually be replaced by electrically powered models. Dr. Jarvik has experimented with an electrohydraulic mechanism. An impeller of an axial-flow pump is connected to the rotor of a brushless direct-current motor. Reversing the rotation of the pump will reverse the direction of the flow. The fluid actuates the diaphragm just as compressed air does. The device would still require an external battery power supply to be connected to the heart by a small cable passing through the patient's chest.

The prototype produce by Dr. Rosenberg consists of a cylindrical electric motor that connects the two ventricle casings at the base of the heart. An internal cam regulates the stroke of pressure plates which force blood into the chambers at either end of the cylinder. The patient would then have to carry a small battery powered pack that would transmit energy to the converter via a transcutaneous radio frequency.

Although Barnard Clark's was the first permanently implanted Total Artificial Heart, there had been numerous experiments performed on animals prior to his surgery. As stated earlier, the first experiments were done on dogs by Dr. Kolff at the Cleveland Clinic. The hearts were initially designed with a plastic casing, a pump without a diaphragm, and an external air compressor power source. These devices kept dogs alive for several hours. Later, designs using electrically powered mechanisms were tested but abandoned because they caused excessive destruction of blood cells. Experiments with hearts having different shapes and smoother materials were performed in the 1960's on calves leading to survival periods of more than a few days. Attempts were made to internalize the power source by using nuclear power but failed due to excessive radiation. Along with the problem of blood cell damage, the artificial hearts made during this period also suffered from mechanical and material failure.

In the early 1970's a series of developments made the feasability of the artificial heart more promising. A major breakthrough was the design of a mechanism whose pumping element was a diaphragm. The first heart used a diaphragm made of smooth silicone rubber. The new heart was free of problems with mechanical breakage and hemolysis, but the material caused excessive blood clotting.

In order to overcome the clotting problem, tiny fibers of Dacron were attached to the diaphragm in one experiment and a layer of natural tissues were attached in



The Jarvik-7 heart works in this manner: blood enters the atrium (1) and passes through the artificial right ventricle (2). Using air pumped by the external power supply, the rubber diaphragm (3) forces the blood into the pulmonary arteries (4). Oxygenated blood then returns from the lungs into the artificial left ventricle (5), and is carried to the aorta, which leads to the rest of the body's arteries. Courtesy of Time .

another. The inside of the heart would become coated with a smooth layer of fibrin, the clotting agent in blood, which would cease the formations of small clots. This design increased the survival time to two weeks, but the buildup of fibrin eventually impaired the motion of the diaphragm.

In the mid 1970's, the Jarvik-3 artificial heart with the new three—layer diaphragm was tested and within a few years calves were being kept alive for up to four months. Subsequent improvements on the Jarvik-3 design yielded the fifth and then the seventh model. By 1979, the Jarvik-7 had achieved a survival period of 221 days.

Although the doctors at the University of Utah had been experimenting for over a decade, the first artificial heart implanted in a human was installed in 1969 by Dr. Denton Cooley of the Texas Heart Institute. It was used as a "bridge" heart, sustaining the life of the patient for 64 hours until a donor's natural heart was found. The experiment was a success, but no further trials on human patients were attempted until 1982.

On December 2, 1982, Barnard Clark became the recipient of the first permanently implanted artificial heart. By all accounts, there was no real hope for Barney Clark to recover enough to leave the hospital. By the time he died, 112 days after the operation, Clark's new heart had been replaced twice due to mechanical failure of the valves. He also suffered many strokes due to chemical imbalances in his blood caused by the anticoagulants and drugs given him to prevent clotting and infection.

Since the death of Barnard Clark in 1983, there have been three other successful permanent artificial heart implantations. William Schroeder's and Murray Haydon's hearts were implanted at the Human hospital and the third man's heart implant was performed in Sweden. Jack Burcham also received an artificial heart, but died only ten days after the surgery. Bill Schroeder has by far faired the best of all the recipients. He has been kept alive by the heart for close to a year, but he too has suffered various strokes, caused by blood clots, which have partially disabled him.

"THE FOOD AND DRUG ADMINISTRATION has sanctioned the use of the artificial heart only in terminally ill

Continued on page **18**

Computer-Made Joints: Marrying

by April Stokes

"Steve Austin, astronaut, a man barely alive. We can rebuild him, we have the technology. We can make him better than he was . . . stronger, faster."

"MANY OF YOU probably saw the "Six Million Dollar Man" series run on television. Actually, we do not have the technology to do this yet, but we are making substantial gains to improve the possibility of it happening someday. The process of making artificial hips, knees, and other joints used to be an imprecise craft, irregardless of the best efforts of bioengineers. As far back as 1826, John Rea Barton built a primitive form of an artificial hip joint, and for more than 100 years after that, there have been many others who have worked with varying degrees of success.

A problem was common to all of them: the implanted devices eventually broke, or were loosened to the point where they had to be removed. In fact, it was not until the early 1960's that Sir John Charnley in England devised a joint using a metal stem and ball that rested in a plastic socket, both parts being fixed in place by bone cement. Charnley's success represented the beginning of an orthopedic revolution—a revolution that has been taken a step further through the use of computers.

KWANG-YONG QUEK

April Stokes *is a junior, majoring in Computer Engineering. In addition to being Associate Editor of MECHELECIV, she is Vice President of the GWU Black Engineers' Society. This fall, April is working as a co-op student for the Xerox Corporation in Rochester, New York.*

Computer aided design—the technology used to develop cars and airplanes—has now entered the field of medicine. Through the use of CAD, three-dimensional color images of bones can be cut apart and put back together again on the computer screen. Thus, surgeons can not only design artificial joints, but they can also simulate surgical procedures before performing them.

A NEW LOOK INTO THE HUMAN BODY WITH CAT

FROM THE TURN OF THE CENTURY until the mid-1970's, surgeons used standard X-rays to diagnose their patients. But the main shortcoming of X-rays was their depth of field: in other words, X-rays show everything in the line between the X-ray tube and the film, including items such as lint! Thus X-rays produced only a vague image, and surgeons relied primarily on their own experience.

Then, computer-aided tomography, C.A.T, entered the picture. This sophisticated X-ray technique uses computers to sharpen the focus of X-rays to create digital "slices" of patients: ultra-thin, high-resolution cross sections that make it possible to see every millimeter of skin and bone. CAT scanning involves the premise that narrow X-ray beams pass through a patient from hundreds of different angles and are detected electronically. Consequently, a computer can reconstruct these multiple images into a representation of a human cross-section taken along any desired plane. There is just one problem: these hi-tech images are only in two dimensions. This can be compared to trying to see a picture of a loaf of bread by looking at each slice. Up until this point, a surgeon would have to "try out" a solution in the operating room and wait for the patient to recover to observe the consequences.

THE POWER OF CAD

THE OBJECTIVE WAS TO DEVELOP computer graphics programs that could take the data generated by the CAT scanners and reconstruct it into a whole image, much like stacking the individual slices of bread back into a solid loaf. Without CAD, a surgeon repairing a shattered part of the hip would have to whittle the new piece, and then implant it. With CAD, he/she can, while using the computer's lightpen as a scalpel, assess the proper size and orientation of the wedge of bone to be removed, "sever" the femur, and "remove" the bone fragment. The computer then reconstructs the bone (as nature would do over a long time period) and modifies the model of the patient's musculoskeletal structure to give an animated, walking figure on the screen. If the surgeon decides that this first choice is not optimal, the procedure can be restarted just by clearing the screen. This process can be repeated as often as

"In roughly four minutes, their computer will draw a three-dimensional blueprint of the joints, which doctors and engineers can refer to."

Medicine and Mechanics

Artificial knees, like the one shown above, can be designed by computers to exactly match a person's natural gait. *Courtesy of* Technology Review.

necessary until the best solution to the problem has been found.

THE MAKING OF ARTIFICIAL JOINTS: BEFORE

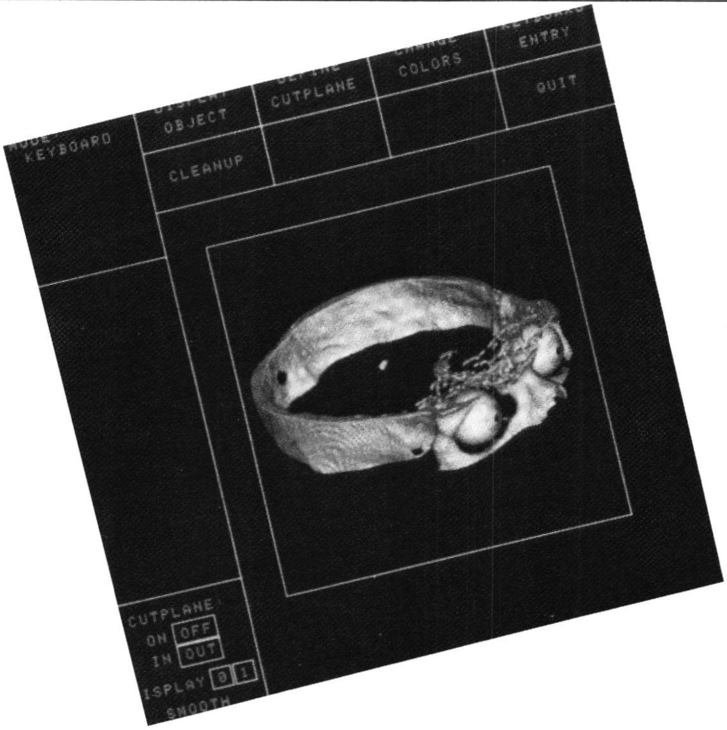
THE PREVIOUS PROCESS for making artificial joints was a painstakingly slow and expensive one. To duplicate the complex joints required for walking, for, example, a designer drew a model for kill-display—a prosthesis from a patient's X-ray. Then a technician took a block of metal, machined it with tools such as lathes and milling machines, and carefully finished it by hand, filing off a bit here and rounding a rough edge there, trying to shape the metal to fit the patient. Even with all this care, however, the surgeon often had to cut away extra bone and tissue to make the prosthesis fit.

THE MAKING OF ARTIFICIAL JOINTS: AFTER

WITH CAD, computers do in minutes what used to take humans days—even weeks—to complete. Because it takes less time and manpower to make the computer joints, the new joints cost about one-third less than the man-made ones: $1000 to $2000 for a computer-made hip joint as opposed to $1500 to $2500 for a man-made one. To design an artificial joint by computer, surgeons first feed X-rays of the patient's real joint into the computer. Taking this information into account, as well as the patient's weight, age, and ability to move, the computer recommends an implant from one of several standard joint designs in its program. If the CAD system does not have a model in its memory that works, it will generate another one that does. Surgeons and engineers can then fit this standard joint exactly to the particular patient by punching instructions into the computer. In roughly four minutes, the computer will draw a three-dimensional blueprint of the joint that doctors and engineers can refer to. The surgeon can even indicate where he will make his incisions, and he/she can also perform a sketch of the operation to come. Computers manufacture the actual joint, too: a paper tape, which has been coded by the computer with the precise design coordinates for the implant, instructs the machines that make the joint exactly how and where to cut the raw materials. In all, it takes four days to manufacture it. On the other hand, without the computer, the same joint takes four days to design and THREE WEEKS to manufacture.

THE NEW METAL OF CHOICE: TITANIUM

NOT ONLY have there been modifications in the process for making joints, but there have also been modifications in the prosthesis itself. When Sir John Charnley did his first implant, he used raw Teflon for the cups and stainless steel for the stem and ball, but he found that the Teflon wore out quickly. In 1963, he began using high-density polyethylene for the cups, a practice that still continues today, although there is a new metal that is fast becoming the metal of choice: titanium. Titanium's high ductility allows the load on the hip to be distributed evenly, making it



This cross-section of a skull, displayed on a computer terminal, shows the phenomenal capabilities of the Phoenix Insight system. Insight can draw objects without sacrificing their natural concavity or density. Courtesy of New York.

more like the real thing. This is important, because if the prosthesis has taken all of the load and the bone is unloaded, the bone assumes it has no work to do and tends to disappear.

A LOOK INTO THE FUTURE

STILL, THERE IS NO ASSUMPTION among orthopedists that the ideal in prosthesis has been achieved. Research continues to yield longer-lasting implants, with an emphasis on finding an agent other than cement for fixing the implant to the bone. One answer appears to be **biological fixation**, which allows the bone to grow directly into the prosthesis, without the use of a binder. This is accomplished by fixing a porous metal surface, or skin, to the implant, into which the bone can grow. This is a technique being used in operations to replace sections of cancerous bone. There are still some problems that have to be solved before use of this procedure can become widespread; however, it is thought to be the method of fixation in a year or so.

THE HOSPITAL FOR SPECIAL SURGERY

"AN INNOVATOR IN THIS NEW TECHNOLOGY is the Hospital for Special Surgery on Manhattan's East Side in New York. There, prosthesis are developed and manufactured. Right now, no other hospital in the country has this capability. The most any other hospital can do is alter a manufactured prosthesis by cutting off a piece, if it's too big. The hospital plans to license the technology for making the joints to Johnson & Johnson, Inc., the pharmaceuticals company. They, in turn, will set up terminals in other hospitals. Physicians will be able to design prosthesis themselves by using terminals in their hospitals to gain access to a computer at a central facility run by Johnson & Johnson. The computer's software will contain all the structural design criteria. Once the prosthesis has been designed, Johnson & Johnson will either assemble it from off-the-shelf parts or use CAM (Computer-Aided Manufacturing) equipment, if custom work is required. In the next five years, it is expected that approximately 50 hospitals will acquire the new technology.

THE LEADING MANUFACTURERS

TWO TECHNOLOGICAL LEADERS IN THIS FIELD are Contour Medical Systems of Mountain View, California, and Phoenix Data Systems of Albany, New York. Their systems are being used in hospitals affiliated with New York University, Stanford University, and the University of Wisconsin, among others. For example, Contour has developed the Cemax 1000, a three-dimensional reconstructive display system that examines, measures, and manipulates high-resolution views of a patient's anatomy. In some cases, these anatomic studies pinpoint problems that doctors could not have visualized before. The Cemax 1000 costs roughly $175,000. Contour also has a patented process for using the numerical data to run a machine that actually makes implants. Phoenix's Insight is a faster and more expensive (roughly $500,000) solid-modeling system that can represent the real density of objects, not just an image made up of surface contours.

Because they are custom-made, computer-made joints fit better, work better, and last longer than man-made joints. In addition, the reduction in time that a patient is on the operating table improves the possibility of there being no complications afterwards. More and more hospitals are purchasing these new CAD/CAM systems because they make surgical facilities more productive and more economical. Furthermore, the technology developed can be expanded to include other medical disciplines, such as plastic surgery. And, although "bionics" as such has not been fully realized, with both the medical and engineering fields working together, the idea does not seem as unrealistic as just a few years ago, when Steve Austin was science fiction. ■

Satellite Technology Comes Down to Earth to Treat Heart Patients

by Deirdre Maull

"WE HAVE ALL SEEN products on supermarket shelves that advertise being used by astronauts in space. Scientists and engineers are constantly discovering more and more valuable outgrowths of space technology. Following are descriptions of two implantable cardiac assist devices that will both extend the lives and reduce the mortality rate of those suffering from heart disease or heart malfunction. A notable characteristic of both devices is that they incorporate technology that was originally developed by engineers for use in spacecraft.

PROGRAMMABLE PACEMAKERS

ALTHOUGH THE PICTURE improves every year, heart disease still remains the leading cause of death in the United States. Many fatal heart attacks result from a malfunction of the neuroelectric control system that regulates the periodic contraction of heart muscles. With early detection of such malfunctions, a pacemaker can be implanted to generate an electrical pulse that controls heart muscle contractions.

Early pacemakers used mercury-zinc batteries, which were heavy and short-lived. Surgical replacement of the battery was necessary every eighteen months or so. This situation changed in the late 1960's, when it was proposed that the battery could be recharged via electromagnetic transmission through the intact skin. Rechargeable batteries, of the type used in satellites, could solve the short-life problem.

In 1973, engineers perfected the first commercially available model of a rechargeable pacemaker. It employed a hermetically- sealed, rechargeable unit containing a single-cell, nickel-cadmium battery, such as those used in most satellites. Today, an even more advanced battery, based on lithium electrochemistry, is used.


KWANG-YONG QUEK

Deirdre Maull *is a sophomore, majoring in Mechanical Engineering. She is a recipient of the GW Engineering Honors Scholarship. Prior to enrolling at GW, she attended Georgetown University, in Washington, D.C.*

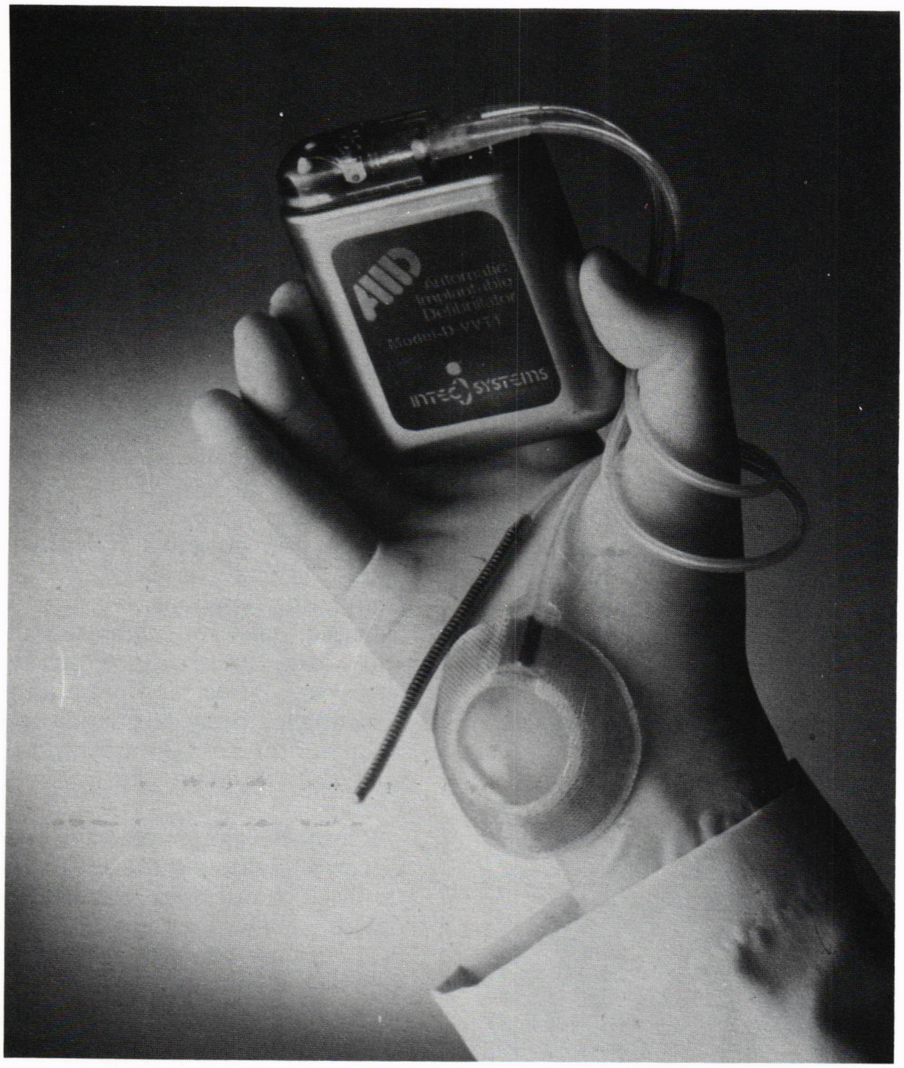
This battery has exceptionally high energy densities and a very low self-discharge rate.

"PACEMAKER TECHNOLOGY advanced further in 1979, when a programmable unit was introduced. This system had two-way communications capability and was based on technology developed to send coded instructions to unmanned satellites. The system allows a physician to communicate with a patient's pacemaker by means of telemetry signals. Where earlier pacemakers delivered a fixed type of stimulus once implanted, the new system can be "fine—tuned" to meet each patient's individual needs. As many as six heart stimulating functions, for example, pulse rate, amplitude, and width, can be adjusted as necessary. When reprogramming is complete, the system sends back a copy of the new settings, from which a permanent setting can be made.

Recent developments have been directed toward a more advanced unit, which offers an implantable device, smaller than any previous unit, and incorporates substantially increased programming capability. This system is capable of sensing and stimulating either or both chambers of the heart and offers better control over, and monitoring of, heart functions.

AUTOMATIC DEFIBRILLATORS

OVER ONE MILLION AMERICANS suffer heart attacks each year. Approximately half survive the attack, but, of those, 50,000 die within one year. Most of these deaths result from **venticular fibrillation**, a condition brought on by excited or erratic contractions of the heart. When it can be applied in time, electric shock defibrillation is generally successful in restoring a normal beat pattern to the heart. Unfortunately, most of those who die from a fibrillation episode are too far away from a hospital, where they could receive proper treatment.



"The improved AID (Automatic Implanted Defibrillator) . . . places within the bodies of persons at risk, a sensing system to detect the onset of fibrillation . . . and to automatically restore the heart to a normal rhythm." Courtesy of NASA.

An **automatic implanted defibrillator** offers a solution to this problem, by placing within the bodies of persons at risk a sensing system to detect the onset of fibrillation (or other potentially fatal arrhythmias) and to automatically deliver a balanced electric pulse to restore the heart to a normal rhythm. In one study, such a device was implanted in 238 human patients at 20 medical centers. Of these 238 patients, 70 have had a total of 205 spontaneous arrythmical episodes in which normal heart rhythm was restored by the implanted device. The annual death rate for this group was reduced to only 4.6 percent from typical rates of 30 to 66 percent.

Technology from the space program is being applied to redesign the current device using principles and components whose capabilities and reliability have been validated by use in spacecraft. It will soon include an external recorder capable of monitoring and recording the patient's ECG (Electro CardioGram) any time his/her heart goes into fibrillation. A spacecraft-type, low power, solid-state digital memory is used to obtain an 80 second recording of a fibrillation episode. This would also provide a patient with an indication that a defibrillator shock was administered.

"THE IMPROVED AID (Automatic Implantable Defibrillator) will provide a demand pacer function to restore normal rhythm to an asystolic (fully expanded) heart, an automatic test sequencer and low battery voltage detector, programmability allowing adjustment by the physician, early warning of an impending defibrillation episode, and a four function internal event ECG recorder.

As evidenced by the recent conspicuous developments in artificial heart and joint technology, engineers are now applying their skills directly to the solution of medical problems. Technical advancements in medicine are no longer merely the result of secondary application of developments originating in aerospace or other fields. The emergence of bioengineering as a separately identifiable discipline assures society that engineers will remain a permanent part of the medical team. ■

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LIVING ON THE WIRE:
Inside a Modern Shock Trauma Unit

by Lilimar Avelino and Swati Patel

This article was written based on independent research and interviews with Kiran J. Parikh, M.D. Dr. Parikh is a general surgeon actively practicing in the Baltimore, Maryland vicinity. He graduated from the University of Bombay in India, and completed his general surgical residency at Saint Agnes Hospital in Baltimore. He has also worked at the University of Maryland Shock Trauma Unit, as well as in Pediatrics surgery at Johns Hopkins Hospital.

Emergency! Emergency! . . . serious car accident . . . possible cause, drunk driving . . . trauma victim . . . severe multiple injuries . . . vital signs rapidly decreasing . . . ambulance and shock trauma unit required immediately on 21st and H St., N.E., D.C . . .

"THIS HORRIBLE scenario is repeated much too often these days. In fact, most fatalities in the United States result from motor vehicle accidents, such as the one above. Others result from fires, burns, chemical spills, falls, sports-related injuries, poisoning, suicides, homicides, cardiac injuries, and radioactive exposures. All of these misfortunes are classified as **shock trauma**. Multiple injuries causing a patient to have unstable vital signs is the definition of shock trauma-related impairments. These injuries usually occur in five major areas of the body:

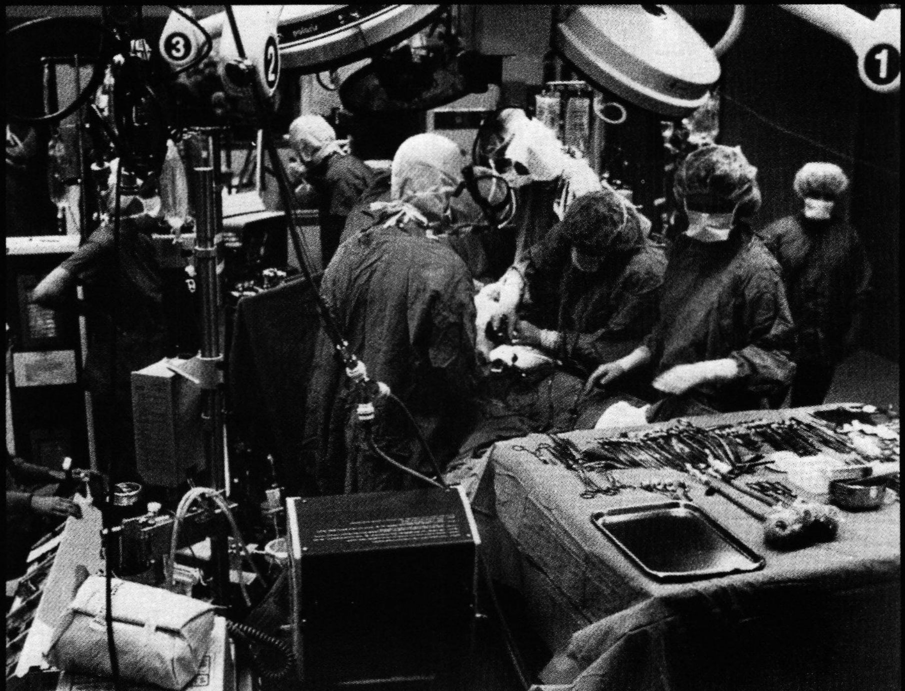
- head or central nervous system;
- spinal cord;
- chest or thoracic region;
- abdominal region;
- the extremities (legs and arms).

"Due to America's increasing advancements in efficient transport [systems], [medical] care, and technology, shock trauma injuries are reduced with the help of medical professionals on duty, twenty-four hours a day," as stated by Dr. Kiran J. Parikh. From his many experiences, Dr. Parikh has watched the efficiency of the shock trauma unit improve tremendously through the following systematic and well-supported procedures.

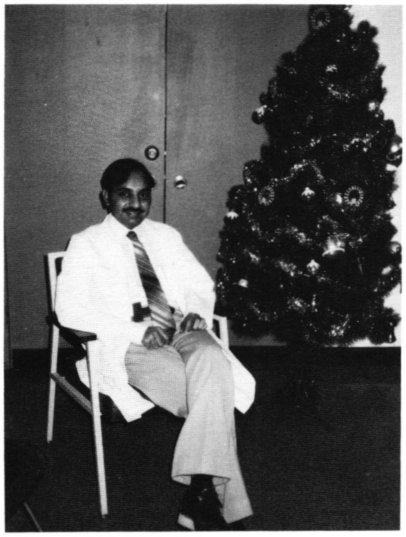
"THE CARE NECESSARY FOR the treatment of accident victims requires several immediate procedures at the site of the injury. Most predominantly used is the "ABC" of shock trauma. Paramedics primarily do three things when in the presence of a disabled victim. First and foremost, they must clear the **airway** (trachea), the passageway leading to the lungs. At the same time, the safety of the neck must be ensured, for the spinal cord may be damaged. Portable accessories such as neck braces assist in this step. After a clear air pathway is assured, **breathing** is simulated through the cardio-pulmonary resuscitation (CPR) method—a process that restores the patient's oxygen intake. Ambubags, electric, and automatic chest compression machines are all temporary breathing units. The last maneuver performed is restoring **circulation**—a process that maintains the patient's fluid supply, depending on whether or not a palpable pulse is found.

The three above-mentioned steps must be established before any diagnostic tests can be performed. The extent of injury is at all times monitored by doctors and professionals in nearby hospitals. Thus, the high performance of the paramedics cannot be achieved without ever-improving communications technology. For example, the Emergency Medical Communication Centers relay messages instantly from the ambulance to the nearest hospital or shock trauma center.

Better treatment for accident victims is attained not only through rapid treatment and



The operating room is the focal point of the modern shock trauma unit. Courtesy of Time.



Even at Christmas, Dr. Kiran J. Parikh is never far from the hospital, where he is needed.

improved communication, but also through the accelerated advances made in medical equipment technology. After assessing the essential procedures at the scene of the accident, more extensive diagnostic tests must be performed at the shock trauma unit. Dr. Parikh described the five major areas of the body which are diagnosed, respectively, with the newest technology:

•Most importantly, **head injuries** are diagnosed first with the help of Computerized Tomography or the CAT scan. Doctors can check the brain for any damage or any unnecessary bleeding caused by the accident. They also use an intracranial pressure bolt to eliminate any pressure in the brain and prevent brain expansion into the spinal cord.

•Next, professionals can examine **spinal** injuries and any fractures by conventional X-rays as well as the CAT scan.

•After checking for complications in the spinal cord, the **thoracic** cavity, including the blood vessels and the heart, is examined for any injuries. Blood vessel damage is diagnosed by the CAT scan, NMR (Nuclear Magnetic Resonance), or arteriograms. An **arteriogram** requires the injection of dye into a patient's blood system. If a blood vessel is ruptured, then the dye leaks out. Along with the blood vessels, the heart is continuously monitored by cardiograms, catheters, and fluid monitors that regulate the amount of fluid entering the heart. Doctors also use a most recent development called the **nuclear medicine test**. Specifically, the test requires physicians to inject a very small dose of radioactive dye into the patient's vein. Any abnormal rupture that may have occurred due to injury may be traced by color-coded dyes. These dyes appear with different intensities to represent the extent of the rupture. Another technique used in examining heart injury is the **Swanganz pulmonary pressure measurement** (an analogy to the intracranial pressure bolt), which utilizes a catheter, and graphs fluid pressure in each chamber of the heart.

Unlike the CAT scan, there is no danger of radiation exposure, because the NMR works based on magnetic fields."

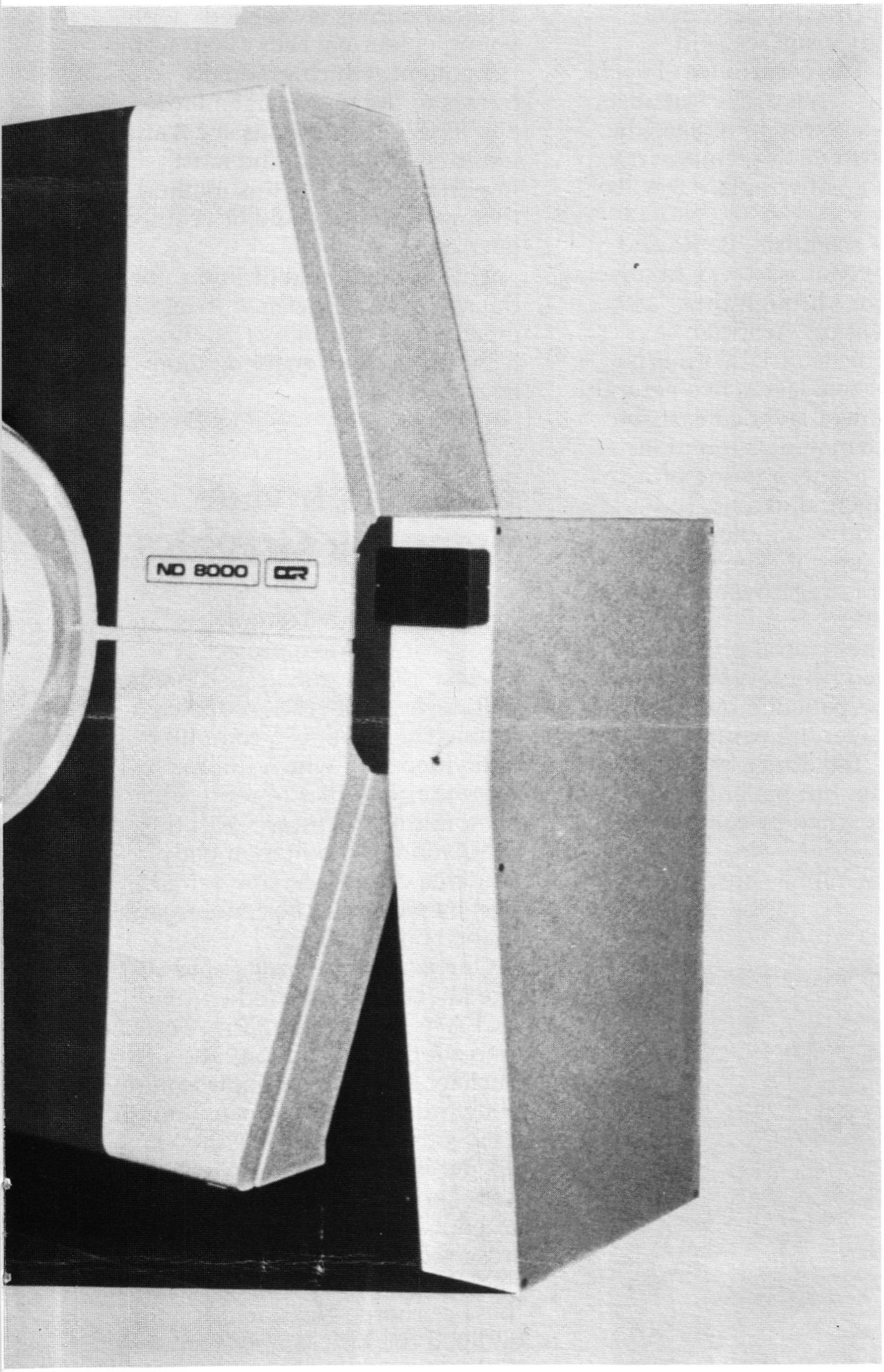
Right: *CAT scanners, like the one pictured here, are used in shock trauma centers to check the brain for damage or bleeding caused by accidents.*

•The fourth body area examined is the **abdominal** region. For abdominal injuries, conventional X-rays and the CAT scan can inspect the lower back, spinal cord, stomach, intestines, liver, kidneys, spleen, and major blood vessels. Also, doctors take barium X-rays orally or anally to analyze these regions. Once again, the nuclear medicine test is used for the inspection of liver and spleen injuries, while special kidney X-rays scan for injuries by means of a dye injected into the renal vein (a vein leading to the kidney and bladder.) All of these injuries must be diagnosed immediately, or they may be fatal to the shock trauma victim.

•Finally, the least important injuries involve the **extremities** or **bone fractures**. These, having the lowest priority, are diagnosed last, for unexamined injuries to the other major areas of the body may cause severe permanent damage to the patient. However, as Dr. Parikh states, "Physicians may shift the priority if the accident damaged any major blood vessels in the limbs.'

"ASIDE FROM UTILIZING pre-existing technology, hospitals have now turned to a most recent and advanced machine known as the Nuclear Magnetic Resonance or NMR scanner. Unlike the CAT

scan, there is no danger of radiation exposure, because the NMR works based on magnetic fields. Since further research is necessary, a limited supply of this new technology is available.



However, doctors and professionals hope that NMR will soon be used in hospitals and shock trauma units, nationwide.

These new technological advancements do have some drawbacks. For example, some dyes may cause allergic reactions, and infections may result form the intracranial pressure bolt, sometimes giving rise to meningitis. Of course, there is always the chance of radiation exposure to X-rays and the nuclear medicine test. These small side effects can be weighed out when considering the life- and-death conditions of shock trauma victims.

In conclusion, doctors, paramedics, and professionals can save the lives of more shock trauma victims with reliable machines and a wide variety of techniques. In the words of Dr. Parikh, "Shock trauma teams in the United States are very efficient—the best in the world. As more and more people become aware of the precautions being taken toward the safety of their lives with dependable machines and diagnostic tests, such as the CAT scan, arteriograms, nuclear medicine tests, fluid monitors, the intracranial bolt, and, most recently, NMR, they will further realize the dedication, care, and efficiency offered by our local hospitals, emergency rooms, and especially, shock trauma centers."

KWANG-YONG QUEK

Swati Patel *is a sophomore majoring in Electrical Engineering. She is interested in the field of medical engineering and would like to go to medical school or do graduate study in biomedical engineering. Swati finds any kind of scientific research especially challenging and rewarding.*

KWANG-YONG QUEK

Lilimar Avelino *is a sophomore, majoring in Electrical Engineering. She wants to coordinate these studies with a Computer Science minor or a Premedical Engineering major. Lilimar is also TECH BRIEFS Editor of MECHELECIV and works as a co-op student for the Naval Research Lab, in Washington, D.C.*

Artificial skin offers new hope for burn victims

"HAVE YOU EVER THOUGHT about what life would be like without skin? It would be pretty uncomfortable to say the least! The skin that covers every square inch of the human body has many important functions that would make it difficult for anyone to live without. It is a vehicle of touch and sensation, a regulator of temperature and fluid balance, and a protector against mechanical injury and infection.

More specifically, skin is a two layer membrane of protection. The lower layer is connective tissue containing the protein collagen, which functions to protect and cushion the body, and houses hair follicles, nerve endings, sweat glands, lymph and blood vessels. The upper layer of epidermis is .01 to .12 millimeters thick. This epidermis is composed of epithelial cells that are constantly growing up to the surface and being sloughed off in a never ending cycle.

Yet, this cycle can be broken in a terrible way. A burn victim can have as much as 90 percent of his/her body's surface skin destroyed. The occurrence of such accidents, is what drove scientists to search for a way to replace the skin of a burn victim temporarily, or to permanently replace it with new skin.

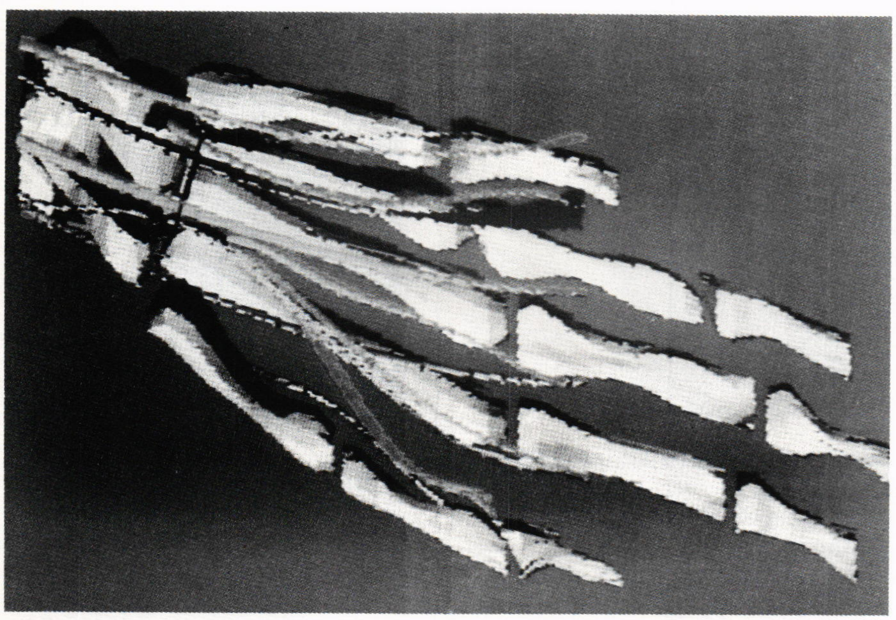
A pair of scientists, Berke and Yannas, have found a way to solve this problem, through the development of "Artificial dermis." The artificial dermis is made up of two layers like natural skin. The lower layer consists of two organic materials found in connective tissue: a tissue protein called collagen, and a polysaccharide—another structural element. The synthetic upper layer is a removable sheet of silicon plastic.

During the natural process of healing, the lower layer is broken down as the patient's own dermal cells grow over the wound. Eventually, the upper layer can be peeled away, but patients still have to be grafted by conventional techniques.

Berke and Yannas are now working on a one step process by which they let the patient's cells colonize the membrane. The artificial dermis is "seeded" with young epidermal cells taken from the patient, which gradually moves to the top collagen layer and forms a continuous sheet after ten to twelve days. The most important aspect of this method is that no grafting would be required later on.

This is a big breakthrough, for the safety and efficiency would be greater than traditional grafting techniques, thus enabling more lives to be saved.

—Rose Province



"Two UCLA associates . . . transferred a human hand to a videodisk, complete with skin, fat, nerves, and muscle." Courtesy of Omni .

Cadavers Invade Computer Graphics

"THANKS TO AN innovative project at UCLA, medical students will never be short of cadavers again. The secret is a computer and videodisk, which utilizes computer graphics to represent anatomical structures. With this simulation of the human body, students can dissect and rebuild part by part the limbs and organs of the body.

One part of the project has already been completed by two UCLA associates, Dr. Roy Meals, an orthopaedic surgeon, and J. Michael Kabo, a computer expert. They transferred a human hand to a videodisk, complete with skin, fat, nerves, and muscle. Meals and Kabo took a cadaver's arm and sliced it into 176 extremely thin cross-sections. Then, they photographed and enlarged 160 of these portions. Next, felt tip pins outlined the nearly 7,000 contours of the bones, blood vessels, and nerves in the 160 pictures. Each picture was then loaded into a minicomputer with the help of a hand-held electromagnetic "puck", and digitizing tablet. Finally, after all the data had been recorded, Kabo wrote a program to smoothly link the 160 cross-sections.

—Vaiji Ramaswami

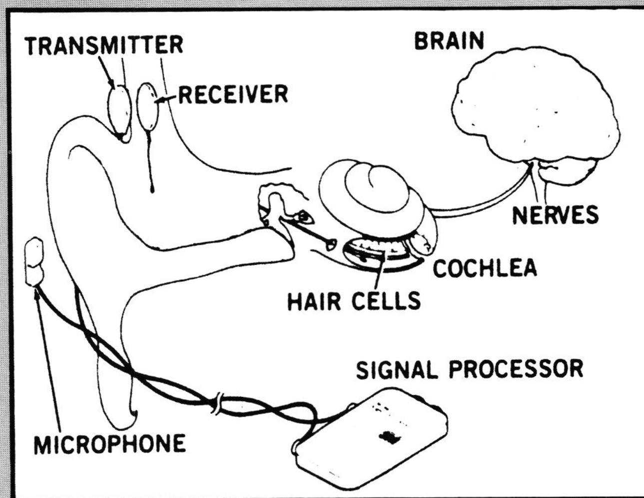
Clone a Protein, Kill a Tumor

"ONE IN FOUR Americans develops cancer, making it the second leading cause of death. In individuals 36 to 64 years of age, cancer causes more than one-third of the deaths. The most fatal of these are lung, intestine and breast. A single cancer-inducing substance triggers a change in the behavior of cells, resulting in uncontrollable growth. Malignant cancer tumors grow with the help of blood supply through a process called angiogenesis, which is the proliferation of a network of tiny capillaries connecting the tumor to nearby arteries and veins. If the tumor's signal to "feed" it with blood supply were impeded, the growth of the tumor would be arrested.

At the Harvard Medical School, Bert Valle and associates made a major discovery of the protein responsible for stimulating angiogenesis. They removed a patient's cancerous colon cells and cloned the protein. This major breakthrough will not only help cancer patients, but also individuals with other ailments. For example, allowing for the proliferation of angiogenin can increase the blood supply of heart attack patients as well as victims of tissue damage. On the other hand, obstructing the growth of angiogenin can definitely stop tumor growth. As a new development, the cloned angiogenin protein still requires many tests. Yet, it is obvious that scientists have scored a major battle in their fight against cancer tumors with the help of the protein, angiogenin.

—*Lilimar Z. Avelino*

Cochlear Implant Allows the Deaf to Hear



The 3M Cochlear Implant System is the start of an effort to restore hearing to the deaf. Sounds are picked up by the microphone and transmitted to the brain via electrical stimulation of the auditory nerve. Courtesy of Popular Science .

"ONE OF THE MOST DIFFICULT disabilities to overcome is loss of hearing. Approximately two million people exist in their own world of silence. Now, the 3M Cochlear Implant System, with help from the Ear Institute in California, comes to the rescue with cochlear implants that allow deaf people to at least hear sounds.

The production of these implants wouldn't be successful without some knowledge of how the human ear works. Sound waves travel down the ear canal into a bodily tissue called the eardrum. Sound then enters the inner ear or **cochlea**, which consists of tiny hairs and a thick fluid. The movement of the fluid, due to vibrations of the eardrum, causes electricity to flow from the tiny hairs and through the auditory nerve, leading to the brain. Deafness occurs mostly because of some injury to the 30,000 hairs in the cochlea, stunted inner ear bone growth, or any degeneration of the auditory nerve in the cochlea.

3M system's cochlear implant converts sounds into electrical stimulations of the auditory nerve. In order to use the implant, a deaf individual must wear a microphone. A signal processor amplifies the signal and sends it to a transmitter behind the ear. The signal penetrates the skin, while a surgically implanted receiver, consisting of two electrodes, permits the stimulation of nerve fibers and triggers a response in the brain.

This advancement for the deaf especially increases a lip reader's ability to understand speech. Thus, he/she can better control his/her volume of speech. Yet, it doesn't allow for the necessary determination of sounds to understand all speech. In the words of Dr. Robert J. Oliviera, the project manager for products of the Cochlear Implant System, "We're five to ten years away from making the quantum jump to producing more natural signals."

—*Lilimar Z. Avelino*

HEART:

Continued from page 7

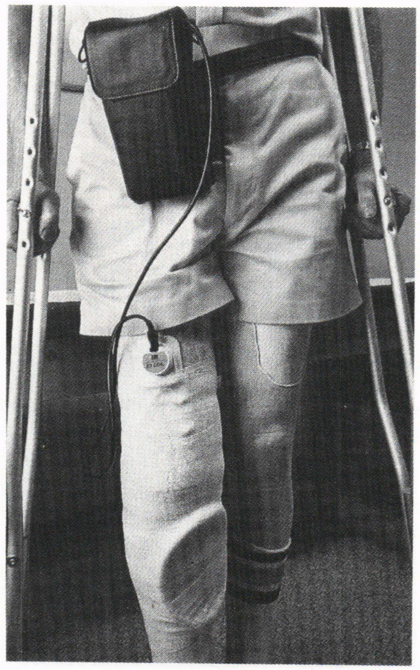
patients and persons awaiting a natural heart transplant. For this reason the ages of the heart recipients have thus far been well over the accepted limit of fifty years old for a human heart transplant. Also, their health condition has been so precarious that most of the time is spent just keeping them alive instead of conducting experiments that could lead to valuable improvements.

Some have said that the use of the permanently implantable artificial heart in humans is unethical. If those involved in the five experimental cases to date are to be blamed in any way, it could possibly be for experimenting on humans before the technology was sufficiently advanced. However, without the information received from these human operations, there would be no hope of ever achieving a workable artificial heart.

Critics also claim that the technology needed is too expensive. Incidentally, the heart itself is relatively **inexpensive** ("only" about $18,000) ; rather, it is the life support systems and the post-operative care that run up the big bills. It is hoped that in the future, the technology can be simplified to a level where mass production could bring the costs sharply down.

The real need for a substitute for natural heart transplants is unquestionable. Out of the 30,000 or more people requiring a new heart, only about 50 receive one. Since there is no known cure, other than transplants, for degenerative heart disease, people are dying for want of a working, life—sustaining heart. For this reason, a practical, mass-produced TAH will be an accomplishment gratefully accepted by those people who have learned to look to the medical technology community for modern "miracles', which give others a second chance at life. ■

Electric Technique Heals Badly Fractured Bones



A new, portable power source gives the fracture patient greater mobility. Courtesy of Fortune.

"INJURIES TO THE skeletal system and to adjacent soft tissues are common in all types of major accidents. One injury is called a fracture, that is, a crack or break in a bone. The most prevalent causes of fractures are motor vehicle accidents, falls, sports-related accidents, and slight injuries in older people who have brittle or abnormal bones. Due to the severity of some accidents, some fractures refuse to heal, because body signals cannot reach the fractured bone tissue. The corrective treatment most often used by doctors and professionals is to graft or pin bone tissue from another part of the body onto the break. Now, there is an alternative solution developed by Electro-Biology Inc. that utilizes electric current.

This simple machine called Bio-Osteogen has an electric coil that fits over the patient's cast. It sends magnetic waves into the bone to imitate the body's signals, since the body is unable to heal it normally. A portable power source operates the unit, which is programmed at a precise sequence of pulses for each patient. Older units limited a patient's mobility, because patients had to plug the machines into household sockets for power supply. On the average, patients wear it ten hours a day for up to four months.

This painless electric technique is not speedy, but has healed 80% of the 40,000 fractures it has attempted to repair. Thus, new techniques, like Electro-Biology's Bio-Osteogen, are minimizing permanent damage due to fractures with the added comfort of mobility.

—Lilimar Z. Avelino

• ARM •

Continued from page 3

visions of unsupervised mechanical arms tearing up peoples' brains. It is important to emphasize that this technology is always very carefully controlled by the human surgeons. A manual control unit is available to help the surgeon make necessary adjustments at any time during the operation. There is also a "panic button," which freezes all the robot's joints in the event of an emergency.

It is also comforting to realize that the surgeons, associated with this project are very cautious and very much aware of the dangers involved. One of them went as far as to say, "I'm not sure I like the idea of telling a machine to operate on my brain all by itself. It is difficult to imagine such a thing without a human there evaluating the procedure as it went along."

—Daniel L. Briller

Is There Life Beyond Tompkins Hall?

Making the Transition to the "Real" World

by Kenneth Everingham

"THOUGH FINDING A JOB is the first priority for graduating seniors, keeping a job is equally important. To do this, the recent graduate faces a transitional period as he/she enters the professional world.

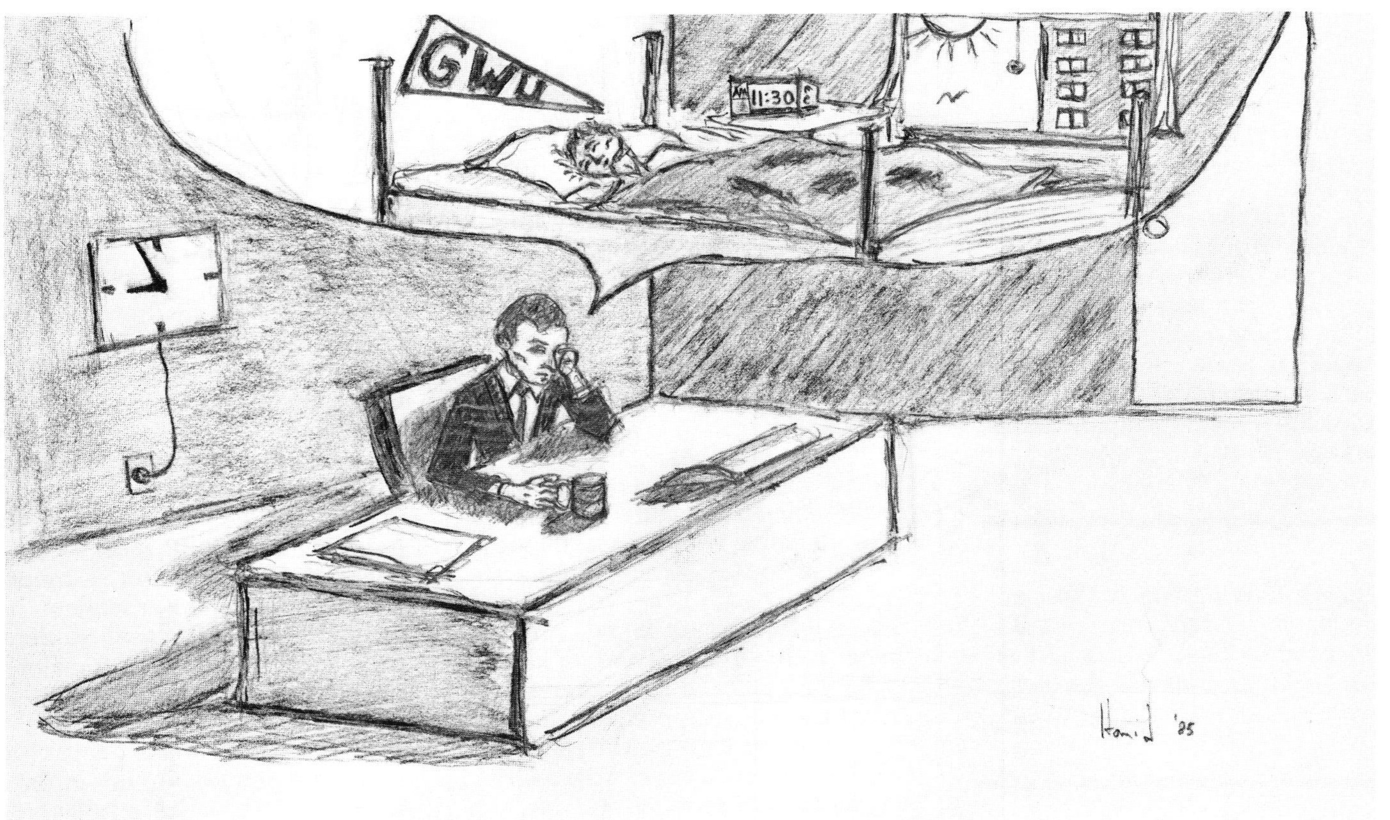
Organizations that employ new graduates were asked, "What are the problems that new graduates face in adjusting to employment?" Employers responded as follows:

- •Learning to communicate effectively through writing;
- •Relating theory to practice;
- •Understanding the organization's management structure;
- •Expecting too much too soon;
- •Developing cooperative attitudes;
- •Accepting responsibility and making decisions;
- •Understanding self limitations;
- •Adjusting to new locations and different life-styles.

Adjustment of potential adjustment problems is the first step to adapting successfully to the new professional environment. Another change the new professional must confront is the way in which work is evaluated. Students are accustomed to receiving regular feedback on their performance through a standard grading system. However, regular progress reports are not the standard practice in the business arena. As a professional, you should solicit feedback from supervisors, as well as fellow co-workers, to obtain regular feedback on your performance.

ANALYZING THE ORGANIZATION

CRUCIAL TO SUCCESS in a company is understanding the organization's structure. This includes the formal structure, as demonstrated in an organizational chart or a policy and procedures manual, and the informal systems of organization and communications. Find out how decisions, and who the knowledgeable individuals are within the organization.



In analyzing the organization, it is critical to understand the company's mission and goals, the process to accomplish these objectives, and how individual jobs contribute to the success of the organization. It is a process of defining how each worker and supervisor's responsibilities function as a unit (the parts), contributing to the company's goals (the whole). Peggy Schmidt in *Making It On Your First Job* adds, "It is important to remember that the organizational structures often function on ego personalities) rather than efficiency." Therefore, make people feel needed, and make them feel that they are contributing. There are other ways to learn about your new employer:

(1) Identify mentors (someone with more experience who will take you "under their wings') and co-workers who will provide information on how office systems work.
(2) Put ideas in writing. This will help develop, plan, and present ideas in a logical manner and is also a good method of protecting your ideas.
(3) Save the best ideas for individual discussion with your supervisor rather than a meeting where they can be lost in the shuffle. Understanding the structure of the work environment is very important, as is cultivating professional relationships with co-workers.

Kenneth Everingham *is Assistant Director of the GWU Career Services Center and the Center's Liaison to the School of Engineering and Applied Science.*

PROFESSIONAL RELATIONSHIPS AT WORK

Dr. John Crites, a University of Maryland professor, perceives two major factors influencing job success and advancement: achievement, the performance of job functions and responsibilities, including the feeling of individual accomplishment and contribution to the organization; and, affiliation, or "getting along" with your co-workers and boss. The most important of these factors for surviving a job and advancing in the company is "getting along" with others. Seventy-five percent of the people who leave a job by choice or get fired cannot get along with their co-workers. Some suggestions on getting along with co-workers include:

•Be a good listener. A person feels important just by listening and responding to their message.
•Listen to all staff. Secretaries and other support staff are often overlooked, though they are the best sources of information.
•Cultivate new working relationships and sources of information. The more you know about the activities of the organization and the nature of your co-workers' relationship to fellow workers and the company itself, the more valuable you become to the organization.

Peggy Schmidt, also recommends tips on "how to keep the happy."

•Make sure you understand your boss'' expectations and priorities. Writing down your responsibilities will help you get through your first weeks.
•Keep your boss up to date on what you're doing. This can keep your boss off your back, and it reassures your supervisor that you're worth your paycheck.
•Follow up on all your supervisor's requests right away. Once you take care of the request, let your supervisor know. This is one of the quickest ways to gain his/her confidence.
•Be willing to take on new responsibilities.
•Try to anticipate busy times at work. Get a feel for the rhythm of your business'' work cycle. Manage your time effectively and plan ahead. This will demonstrate "executive thinking.'
•Set your priorities and meet deadlines.
•Develop visibility and project a self-confident image.

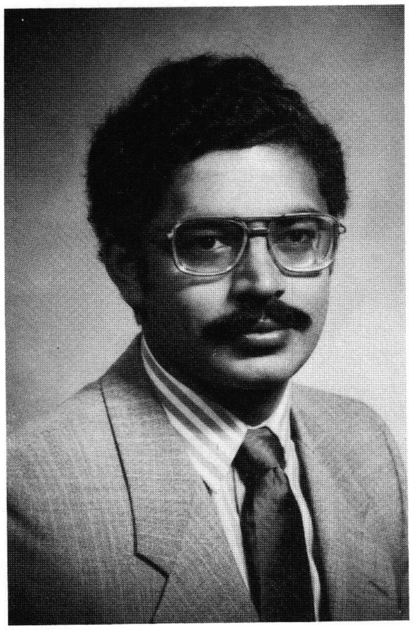
THE CAREER SERVICES Center has additional resources about "first job survival", including handouts on organizational structure and "action ideas" for advancement. In addition, there are books on job survival and career planning for the early stages of your career. Several outstanding books on these topics include "Making It On Your First Job", by Peggy Schmidt, "Office Politics: Seizing Power, Wielding Clout", by Marilyn Kennedy, and "Career Planning and Placement Today", by Randall Powell.

"IN SUMMARY, the steps for a successful transition from college to career are:

•Learn your organization's goals;
•Understand the responsibilities assigned to you and to your co-workers and how they contribute to the company's objectives;
•Observe your boss'' style of managing;
•Learn to get along with your boss and fellow co-workers.

Understanding the work environment, and being aware of possible adjustment problems during the transition from student to professional, will play a major role in your job satisfaction and overall happiness. To read more about surviving your first job, visit the Career Services Center in the Academic Center, Suite T-509.

A letter from the Council President:



I am taking this opportunity to share with the SEAS community my thoughts and experiences regarding the Council's progress during this semester. One of the "good news items" is that the renovation of the D.H. House, which started earlier this summer, is now almost finished. Earlier this semester a new microwave oven and coffee maker were also installed at the House.

The Alumni-Student picnic in September was very successful and was well attended by a fairly large number of Alumni and some students. Unfortunately our copier service was not as successful earlier this semester, mainly due to the absence of an office assistant. We are waiting for a work study student to fill this position.

For its second project, the Council has decided to replace the old typewriter service with a better, more sophisticated word processing facility, for SEAS students only to use at the D.H. House. The council has also decided to get one computer for its office and to be equally shared by the MECHELECIV staff.

The council is currently working on two important projects, which we hope to finish by the end of this semester. The first project is regarding the renewal of the old test file system, for which we definitely need help and cooperation from the students, as well as the faculty. The council would appreciate, if you can provide us any of previous tests which might not be useful for you but could be of great help to others.

For upcoming features, the Council is exploring the possibility of having an Open House for the MECHELECIV magazine and arranging a reception and guest speaker with the joint collaboration of the Engineer Alumni Association. The Council is now planning its events for Engineers' Week to be held in February, and would appreciate your valuable suggestions in this regard.

Lastly, the Council wishes everyone a very Happy Holiday Season.

Zamir Iqbal
President, Engineers' Council

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Engineers' Week Update

February 3rd-8th

•Start practicing your egg drop and building your bridges!

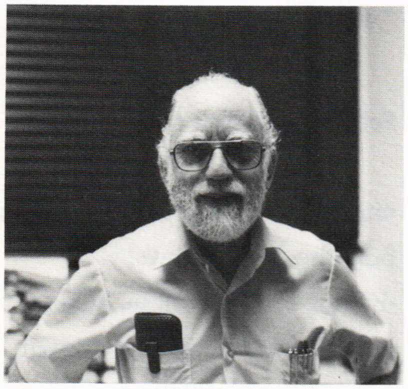
•Engineers' Ball will be held at the J.W. Marriott Hotel downtown; cost: $10 per invitation

•More info to come later . . .

ATTENTION ENGINEERING STUDENTS

- Do you need relevant work experience? or financial assistance?
- The Cooperative Education program has a number of openings with the U.S. Government.
- You must be a full-time sophomore or junior, be a U.S. Citizen, and have a GPA of 2.3 (2.6+ preferred).
- The Co-op Program requires two extra semesters.
- For applications and more information, see Michael Yao, Room 103, Tomkino Hall, **SOON.**
- Other position in private industry may also become available

Have You Considered Biomedical Engineering?



KWANG-YONG QUEK

Professor Marvin F. Eisenberg supervises GW's premedical engineering program.

"CAN'T DECIDE—MEDICAL SCHOOL OR ENGINEERING? Well, GWU's biomedical engineering program will help you answer that question, by preparing you for both options. The program is designed to be both a degree program in electrical engineering and a pre-medical program for students applying to medical school. The course load includes the required courses in electrical engineering, as well as classes in life sciences.

The program's goal, since its inception in 1966, according to Professor Marvin F. Eisenberg is to "try to develop a program toward applying engineering to medical problems and to set up the curriculum so that a student can go in either direction."

On the graduate level, the program offers two tracks: one for mechanical and one for electrical engineering. In all, three broad areas are considered.

•Bioengineering, which is primarily research.
•Service orientation, directed at work in hospitals and doing clinical engineering.
•Medical engineering, which is mainly doing development work.

Presently, the university offers three advanced degrees in this area. They are Masters, Professional and Doctor of Science.

The hospital and the medical school have no direct link to the bio-medical engineering program, but they do cooperate in a number of areas. These range from medical school faculty laboratory in the hospital. That lab, by the way, is staffed by people who have either graduated or currently are in the biomed engineering program.

Research now in progress in their department is in three areas. One is "Evoked Potentials" or separating out from the brain waves, or EEG's the signals that result from eye or ear stimuli. Second is the beginning of the use of an interactive system for patient diagnostics. Third is the development of a microcomputer facility for medical instrumentation in particular, for image analysis.

—*Jeff Winbourne*

Statistics and Medicine Mix in GWU Operations Research Department

THE OPERATIONS RESEARCH DEPARTMENT is currently involved in medical-related research in a number of areas. Professor Nozer D. Singpurwalla is conducting research with Dr. A. Mazzuchi, Visiting Assistant Professor of Operations Research, and Dr. Refik Soyer, Professorial Lecturer in Engineering, at the Institute for Reliability and Risk Analysis.

They are working on a paper in Reliability, the engineering side of Survival Data Analysis, which has applications to medical testing procedures. Their research deals with censored lifetimes of subjects undergoing treatment. For example, if they wish to determine whether a certain treatment or medicine is worthwhile, they examine a statistical representation of the health of a control group of patients who are not receiving the given treatment, and compare this to that for a group of patients who are able to benefit from the results of the treatment. The censored data with which they are concerned arise when some patients in both groups drop out for various reasons, such as suddenly dying from another cause (not the health condition that the treatment treats), or deciding to end treatment, or moving out of town.

Analysts confronted with such censored data find they cannot observe the full effect of the treatment, and must then use Reliability, or Statistics, to best solve the problem. The group is also looking at Bayesian life table analysis. This discipline combines prior assumptions with observed experimental results, and helps to predict, for example, survival curves among cohorts afflicted with the same health problem.

Also, Professor Garth P. McCormick is performing research for the Environmental Protection Agency into the effects of pollution on health of human beings. The EPA wants to find this out indirectly, by taking data from animals and extrapolating it to the human condition. Professor McCormick is using Operations Research optimization methodology to solve the maximum likelihood problems formulated for this purpose. This type of problem formulation is taught in OR 254, Applications of Linear and Nonlinear Optimization Theory. Other health applications of Operations Research are also cited in this course. Students learn, for example, how to estimate the fraction of the population that have genetically high blood pressure; and how to find the optimal nutrition for minimum cost (the diet problem); as well as the relative effects of cigarette smoking on premature deaths.

—*Donald Gross and Jeff Winbourne*

What's Happening In . . .

BES (Black Engineering Society)

The Black Engineers' Society kept busy the early part of the semester by fund-raising, attending the National Society of Black Engineers (NSBE) Region II Fall conference, and planning future activities.

To raise money for the BES and, more specifically, for attending NSBE's conference, a bake sale was held on October 21 in the Marvin Center, and a Halloween candy apple sale followed a week and a half later.

Nearly ten BES members will attend the NSBE's Region II Fall Conference in Pittsburg, Pennsylvania. The conference, which will be held on November 8,9, and 10, offers an enjoyable, yet informative, weekend for its attendees. The conference's theme will lie along the lines of "Retention, Professionalism, and Growth', offering such workshops as "How to Give a Retention Conference" and "Personal Relationships/Dual Career Marriages.'

BES members, at their October 19 meeting, planned some of the remaining fall activities and rescheduled their Career Fair. There will be two guest speakers addressing the BES in early November. One speaker will come from the Chrysler Corporation and the other from the National Consortium for Graduate Degrees for Minorities, Inc. (GEM). The representatives will discuss the attractive opportunities for minority engineers. For example, the GEM representative will inform the BES about chances to gain practical experience in engineering through summer work opportunities at participating laboratories and companies. He/she will also talk about financing graduate studies toward a master's degree in the various disciplines of engineering at a participating member university. Some member employing companies are the Xerox Corporation, TRW, and the RCA/David Sarnoff Research Center, while some participating universities are the Massachusettes Institute of Technology, Howard University, and the California Institute of Technology. The GEM representative is tentatively scheduled for November 2. The Chrysler representative is also scheduled for a visit in early November.

The Career Fair—originally scheduled for the week of October 14—has been rescheduled for January 29 and 30 of next semester. A resume book will be compiled and made available to all corporate and company representatives attending. We are expecting more companies to attend than last year, and the IEEE student chapter here at George Washington will also be participating.

If there are any questions about past, present, or future activities of the BES, or if any student is interested in joining, please contact the Black Engineers Society/3rd Floor, Building HH/2127 G Street, N.W./Washington, DC 20052.

—Ellery Jackson

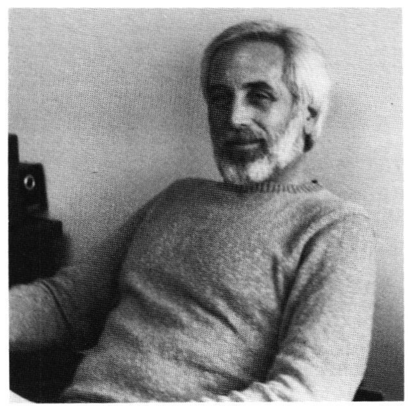
GWU Professor Fights Toxic Waste Pollution

"DEAD FISH FLOATING atop pond water, skies blackened from car emissions, abandoned towns, children suffering from various illnesses contracted from their playgrounds . . .

These are images that arise when we think of the results of toxic wastes. But much has been done over the past decade or so to treat these life-threatening problems.

Some of this research is currently being pursued right here at GWU, in the CMEE department. Dr. Bruce A. Bell, a professor in environmental engineering is conducting studies into treating wastewater from munitions factories.

This work is being done by applying a relatively new biological method to the water in order to break down the poisonous materials. The research is now at the stage where they are able to eliminate all toxins from a sample batch. And, as Dr. Bell pointed out, they are able to keep any new toxins from forming as a residual effect, which is just as important.



EVAN SCHWEITZER

Dr. Bruce A. Bell is working on ways to break down the poisonous materials in toxic waste.

Bacteria, common to ordinary water, is used and is developed to treat the water. Genetic engineering of the bacteria is not used in this experiment. The treatment is carried out on 20 gallons of synthetic waste specimen, which is matched to the real wastewater.

Soon, tests will begin on batches of 10,000 gallons a day of real wastewater. This will be done at a pilot treatment plant in Kingport, Tennessee.

—Jeff Winbourne

Introducing . . .

KWANG-YONG QUEK

Professor Shelley Heller authors the nationally syndicated newspaper column, "All About Computers".

One of the recent additions to the EE/CS Department is the author of a nationally syndicated newspaper column, "All About Computers." The column, which appears weekly, is written by Professor Shelley Heller.

This semester Prof. Heller is teaching courses on Pascal and Algorithmic Methods.

A long time D.C. resident, she is also the co-author of three computer related books and is currently writing a new text on Pascal.

By this spring, Prof. Heller hopes to have organized a computing team to participate in the Association for Computing Machinery (ACM) sponsored matches. Earlier this fall, she put together a team to compete in the ACM match at William and Mary College.

Prof. Heller is married, has three kids, and is an avid tennis player.

—Jeff Winbourne

■

From Greece to GWU

ANOTHER ADDITION TO the EE/CS department faculty is Dr. Nikitas A. Alexandridis, who is here as a distinguished visiting professor from the National Technical University in Athens, Greece.

Dr. Alexandridis is teaching courses in computer architecture and microprocessors, which uses a book authored by him called, "Microprocessors Systems Design Concepts." He is also the recipient of many honors and awards. He is listed in Who's Who in the World, Who's Who in Western Europe and Who's Who Among Intellectuals, among others.

At present Dr. Alexandridis is conducting research in supercomputing systems, focusing on hardware-software adaptability. He is also engaged in study of image processing applied to supercomputers.

Married, he is the father of a nine-year old daughter. His hobbies are swimming and tennis.

—Jeff Winbourne

KWANG-YONG QUEK

Dr. Nikitas Alexandridis is listed in Who's Who in the World Who's Who in Western Europe, and Who's Who Among Intellectuals.

How about Robotics At GWU?

The CMEE Department is planning to make available Robotics Research with Computer Aided Design (CAD). Heading this effort will be Dr. Bruce M. Kramer, a new faculty member in CMEE. Dr. Kramer finished his undergraduate and graduate work at the Massachusetts Institute of Technology. He is presently teaching CE 140, Materials Science, and he is planning to take on other courses in the spring. His research is centered around automated manufacturing processes, including tool wear, new tool materials and geometry, and the use of robotics interfaced with CAD.

Professor Kramer is married. He enjoys playing tennis and being a new home owner. He is delighted to be at GWU and in Washington, D.C.

—Il H. Kim

Keep Track of Career Opportunities with the Career Services Center's Electronic Bulletin Board

The CSC/SEAS Computer Bulletin Board provides Engineering students, faculty, and staff with a direct link to Career Services Center activities. Updates on special employer presentations, campus interviewing organizations and dates, and services offered to SEAS students will be posted on the Computer Bulletin Board.

To tap the Computer Bulletin Board, sign on to the VAX system (4th floor, Tompkins Hall), and type "Career".

—Anne Scammon and Ken Everingham
Career Services Center

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Jeff Winbourne, same as item 4

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Daniel L. Briller
Editor-in-Chief

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